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TRANSPORTATION ACCESSIBILITY: Some References Concerning Applications, Definitions, Importance and Index Construction

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TRANSPORTATION ACCESSIBILITY: SOME REFERENCES

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Among the most frequently quoted passages, found in more recent studies that have utilized the concept of accessibility, is Gould's (1969) statement that "accessibility...is a slippery notion...one of those common terms that everyone uses until faced with the problem of defining and measuring it." (p. 64). Gould's advocacy that accessibility is a 'common term' is undoubtedly supportable, for even a cosary review of current social and economic geographical publications reveals the frequency with which the term is used. Although basic in a geographical vocabulary, definitions of accessibility vary greatly and have helped to produce a complexity of measurement techniques, which add further justification to the above quotation. In general however applications of the term have in common an interpretation that either explicitly states, or implies, ease of contact with some form of spatially distributed opportunities. As such, accessibility would appear to be dependent not only on the locations of opportunities relative to the individual, but also, on the ease of traversing the spatial separation between the individual and particular locations. The achal opportunities that are relevant in a particular situation, as well as the applicable measurement of 'ease', being dependent upon the transportation system, the characteristics of individuals and the character of individual opportunities.

Even given that these factors should be considered in accessibility measurement the primary consideration in index construction is the 'reason' for interaction, for accessibility is definable only with respect to some reason for interaction. Construction of accessibility indices should reflect the needs and aspirations of the 'unit of analysis,' for example, the industrialist seeking to locate a new factory and the individual searching for a desirable residence have different location requirements and preferences, as well as desiring proximity to differing opportunities. It can be expected, and it is found, that accessibility indices are composed of different access measurements, what is also found, however, is that considerable vanety is the measurement techniques that are applied to accessibility index construction. Among the most frequently applied techniques are: 1. applications of graph theory (Garrison and Marble (1964); Murald (1972); Taalk & Gauthier (1973);

2. potential type models (Harris (1954); Clark, Wilson & Bradley (1969); 3. access to a single center (Hawley (1956); Forbes (1964); 4. access to multiple destinations (Yeaks (1965); Kissling (1966); Boume (1967); 5. access from a center (Holm (1970); Clark and Rushton (1970); 6. points scoring techniques (Bracey (1952); Johnston (1966); and 7. indices of transportation provision (Ginsberg (1961); Lijecoski (1972).

Whether transportation accessibility implies locational quality, or the advantages to an individual at a given location, with respect to ease of interaction, the advantages of high accessibility might be expected to help determine the level of interaction and pattern of travel behaviour, and, due to the inherant advantages at that location, high accessibility will be an attractive force in the location decision process. Indeed travel behaviour and location behaviour are the two main research areas that have applied this concept as an explanatory variable. Within both areas of research the concept has been applied to numerous problems, for travel behaviour analyses of modal split (Weiner (1966), traffic generation (Kuhn (1968), journey to work problems (Biel (1972); Hamilton (1968), shopping behaviour (Marble and Bowlby (1968) and information diffusion (Wilbanks (1969) have all been described as being dependent upon accessibility. White in terms of location behaviour studies of industrial location (Ray (1965); Leigh (1969), Tluraco (1971), retail business location (Cohen and Applebaum (1960); Allpass et al (1967), transportation route construction (Black (1967); Kolars and Malim (1970), household residential location behaviour (Kain (1961); Alonso (1964), and the residential development process (Kaiser 1968); Bourne (1968), have also utilized accessibility as a factor of major significance.

A characteristic of most analyses is their emphasis on accessibility as an attribute of a location and of its incasement in terms of distance minimization from locations to opportunities. More recent behaviour and accessibility preference studies have emphasized the role of the individual and perception of individuals, for not only will individuals, firms or organizations, vary in their perception of accessibility but also in their desire for proximity to different facilities, and in the 'weight' they attach to accessibility in any location decision process. The simplified measures of accessibility and the importance attached to accessibility, for example, in some residential location models have justifiably been criticized (Stegman (1969); Johnston (1971). Rather than assuming that a priori relevance of given accessibility measures researchers are now seeking to find the factors influencing accessibility perception and the importance of given levels of accessibility (as in residential location decisions (Peterson and Wemall (1970); Redding (1970).

Independent of the area of research or type of accessibility index used, accessibility is generally studied within a framework of eight areas of interest, which are not mutually exclusive: 1. behavioural analyses - have usually taken a given decision situation and tried to establish the importance of accessibility (Stowers and Kanwit (1966); Daly (1968); 2. conceptual and measurement studies - examine the applicability, definitions and incasuement problems of the concept (Ingram (1971); Briggs and Jones (1973); Stutz (1973); 3. descriptions of accessibility - look at the situation as it exists at a particular point in time or over a period of time (Green (1955); Weir (1972); 4. studies seeking fractional relationships - have tried to relate accessibility to numerous static and dynamic variables, often in order to test or develop theory (Kantner (1948); Pendleton (1963); Kissling (1968); 5. planning applications - discuss desirable qualities in planning, with respect to accessibility to facilities (Chapman (1950); Lynch (1961); Wickstrom (1971), and suitable accessibility measures for planning and forecasts of growth; 6. accessibility preference studies - have mainly, to date, been concerned with residential location, examining individuals preferences for residential location with respect to state facilities, often examined by way of an accessibility game (Redding (1970); Harrison (1972); 7. research reviews - often concentrate on the applicability of the concept to one case of analysis, such as residential location (Pahl and Craven (1970); Johnston (1971); 8. theoretic models of spatial processes or form (Von Thunen (1826); Weber (1909).

The form of this bibliography is intended to provide a guide to the area of interest, type of accessibility measure employed and type of study presented. It is not intended that every essay containing reference to accessibility be included, but that studies within the general framework, given above, be included.

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Haggett, P. 1967. "Network Models in Geography," pp. 609-668 in Chorley, R. J. and P. Haggett (eds.) Models in Geography, London: Methuen.

Brief review of some papers utilizing graph theoretic accessibility techniques.

Haig, R. M. 1926. "Toward An Understanding of the Metropolis: The Assignment of Activities to Areas in Urban Regions," Quarterly Journal of Economics, Vol. 40, pp. 402-439.

Site rent, accessibility and the ability of activities to profitably utilize a given site described as the determinants of land use patterns in cities.

Hamburg, J. R. 1965. "The UNYTS Opportunity - Accessibility Model," Highway Research Quarterly, Vol. 12, pp. 27-29.

Discussion of this land use model and factors that should be considered in any land use forecasting procedure.

Hamilton, W. P. 1968. "Transportation Innovations and Job Accessibility," in Conference on Poverty and Transportation June 7, 1968: Summary and Conclusions and Paper Presented, Brookline, Massachusetts: American Academy of Arts and Sciences.

Basic measures of employment accessibility and an analytic method to calculate employment accessibility are discussed. The paper is mainly concerned with the extent to which potential innovations in urban transportation might improve reverse-commuting.

Hansen, W. G. 1959. "How Accessibility Shapes Land Use," Journal of the American Institute of Planners, Vol. 25, pp. 73-76.

Potential type accessibility index to test the hypothesis that development is dependent on accessibility to employment opportunities and vacant land in an area.

Hansen, W. G. 1959. Accessibility and Residential Growth, unpublished Master's Thesis, Department of Civil Engineering, Massachusetts Institute of Technology.

Harris, C. D. 1954. "The Market as a Factor in the Localization of Industry in the United States," Annals of the Association of American Geographers, Vol. 44, pp. 315-348.

An application of market potential and a 'distance weighted' Shimbel index to the United States.

Harris, B. 1966. Notes on Accessibility, Philadelphia: University of Pennsylvania, Institute for Environmental Studies Discussion Paper.

Spatial interaction can be viewed as a stochastic process, Harris argues that accessibility measurement should reflect this. Probability component is a gravity type index, building in part on the methodological material in the Chicago Area Transportation Study, is proposed.

Harris, B. 1966. Basic Assumption for a Simulation of the Urban Residential Land Market, Philadelphia: University of Pennsylvania Institute for Environmental Studies Discussion Paper.

Harrison, J. D. 1972. Environmental Preferences within Urban Neighborhoods, Norman: unpublished Ph.D. Dissertation, Department of Geography, University of Oklahoma.

Examines the accessibility preference structure of two culturally different sections of the population of Austin, Texas.

Hassinger, E. 1956. Factors Associated with Population Changes in Agricultural Trade Centers in South Minnesota, 1940-1950, St. Paul: unpublished Ph. D. Thesis, University of Minnesota.

Hassinger, E. 1957. "The Relationship of Trade Center Population Change to Distance from Larger Centers in an Agricultural Area," Rural Sociology, Vol. 22, pp. 131-136.

Population growth, population size and distance from nearest large urban center was found to exhibit a greater complexity than is often assumed.

Hawley, A. H. 1956. The Changing Shape of Metropolitan America: Documentation Since 1920, Glencoe, Illinois: The Free Press.

Examines the relationship between distance to metropolitan centers and growth of satellite settlements.

Herbert, B. and E. Murphy. 1971. "Evolution of an Accessibility Surface: The Case of the U.S. Air Transport Network," Proceedings of the Association of American Geographers, Vol. 3, pp. 75-79.

An application of the Shimbel-Katz accessibility measure to the growth of the air transport network of the United States.

Herr, P. B. 1960. "The Regional Impact of Highways," Urban Land, Vol. 19, pp. 3-8.

Potential accessibility and potential models compared; temporal accessibility changes related to population change in New England.

Hillman, M., I. Henderson and A. Whalley. 1972. "In the Market Place: The Hypermarket Debate," New Society, 21st September 1972, pp. 543-546.

Reviews the arguments for and against large out of town shopping centers in Britain. The authors are against their introduction on the basis of household's shopping habits and the problems of accessibility to these centers for much of the population. Improved accessibility to present central city shopping areas is seen as a better solution, which would better serve the population as a whole.

Hillman, M. 1973. "The Social Costs of Hypermarket Developments," Built Environment, Vol. 2, pp. 89-91.

Comments on the surveys conducted in Britain concerning the expected use, merits and demerits of large out of town shopping centers. Includes a discussion of the problems of the individuals accessibility to these centers.

Hodgson, M. J. 1972. "Variability in the Growth of Small Urban Areas," pp. 132-146 in Bourne, L. S. and R. D. MacKinnon (eds.) Urban Systems Development in Central Canada: Selected Papers, Toronto: University of Toronto Department of Geography Research Publication No. 9.

Accessibility variables are applied to an analysis of population growth patterns in Southern Ontario urban centers.

Hoinville, G. and P. Prescott-Clarke. 1972. Traffic Disturbance and Amenity Values, London: Social and Community Planning Research.

A sample survey of 1200 respondents examines accessibility/amenity preferences and finds that when faced with a trade off between amenity and accessibility virtually no one opted for shorter journey times at the expense of a deterioration to their own amenity.

Holm, S. 1970. "Accessibility to National Dental Service in the Province of Norrbolten in 1950 and 1965," Geografisker Annaler, Vol. 52B, pp. 141-152.

Compares changes in accessibility to dental services, in 1950 and 1965, in terms of the number of people in successive travel time bands from each dental center.

Horton, F. E. 1968. "Location Factors as Determinants of Consumer Attraction to Retail Firms," Annals of the Association of American Geographers, Vol. 58, pp. 787-801.

An examination of consumer attraction to retail establishments; comments on 'special accessibility' for retailers which as well as the beneficial effects, often attributed to it, can also be disadvantageous.

Houston, C. 1969. "Market Potential and Potential Transportation Costs: An Evaluation of the Concepts and Their Surface Patterns in the U.S.S.R.," Canadian Geographer, Vol. 13, pp. 216-236.

A critical examination of the relevance of market potential to location theory.

Huff, D. L. and D. F. Marble. 1959. "Economic Impact of Highway Improvements," University of Washington Business Review, Vol. 19, pp. 231-238.

Discussion of the importance of accessibility and related changes in accessibility for land values, retail sales and residential desirability.

Hurd, R. M. 1903. Principles of City Land Values, New York: Record and Guide.

"Since value depends on economic rent and rent on location and location on convenience and convenience on nearness, we may eliminate the intermediate steps and say that (land) value depends on nearness."

Hurst, M. E. E. 1969. "Accessibility and the Town Plan," Association of Pacific Coast Geographers Yearbook, Vol. 31, pp. 115-22.

A general description bearing on many aspects of accessibility and its importance in town planning.

Hurst, M. E. E. 1972. A Geography of Economic Behaviour, North Scituate, Massachusetts: Duxbury.

Brief comments on the role of accessibility in agricultural, individual and land use analysis.

Ingram, D. R. 1971. "The Concept of Accessibility: A Search for an Operational Firm," Regional Studies, Vol. 5, pp. 101-107.

Brief discussion on accessibility measurement followed by an analysis of different 'distance' functions that might be used in accessibility index construction.

Isard, W. 1956. Location and Space Economy, Cambridge, Massachusetts: M.I.T. Press.

The interrelationship between land value and accessibility in agricultural and urban land use theories is described.

Jackson, R. 1970. "Motorways and National Parks in Britain," Area, Vol. 2, Part 4, pp. 26-29.

A description of the effect of motorways on accessibility to British National Parks, and comments on area disparities in relative accessibility.

Jones, E. 1960. A Social Geography of Belfast, Oxford: Oxford University Press.

Demonstrates that social values are relevent in residential location behaviour and land valuation and that these can outweigh the accessibility of a location in importance for residential site selection.

Johnston, D. C. 1971. "Mental Maps: A View of Sabah," pp. 265-272, in Proceedings of the Sixth New Zealand Geography Conference, August 1970, Christchurch: New Zealand Geographical Society.

A mental map study in which respondents were asked to state reasons for their first and last choices in a ranking of places in Sabah, reveals that inaccessibility was a more important factor in last choices than accessibility was in first choices.

Johnston, R. J. 1966. "An Index of Accessibility and Its Use In the Study of Bus Services and Settlement Patterns," Tijdschrift voor Economische en Sociale Geografie, Vol. 57, pp. 33-38.

A crude accessibility index, based on travel time, service timing, daily availability and frequency of bus services for villages to towns by means of a simple weighting system, is applied to an area of North Yorkshire.

Johnston, R. J. 1966. "The Population Characteristics of the Urban Fringe: A Review and Example," Australian and New Zealand Journal of Sociology, Vol. 2, pp. 79-93.

A criticism of the simplified view that gradients of urban influence decrease informerly with distance from the city center.

Johnston, R. J. 1971. Urban Residential Patterns: An Introductory Review, London: Bell.

Includes a review of the hypotheses and observations of several studies that have analyzed the role of accessibility, relative to 'other factors', in the residential location process.

Kain, J. F. 1961. The Journey to Work as a Determinant of Residential Location, Santa Monica, California: Rand Corporation, Memorandum P-2489.

Central hypothesis that households substitute journey to work expenditure for site expenditures.

Kain, J. F. 1962. "The Journey to Work as a Determinant of Residential Location," Regional Science Association, Papers and Proceedings, Vol. 9, pp. 137-160.

Kain, J. F. 1967. "Urban Travel Behaviour," pp. 161-192, in Schnore, L. F. and H. Fagin (eds.) Urban Research and Policy Planning, Beverly Hills, California: Sage.

Discusses the functional relationship of journey to work distances and residential location.

Kaiser, E. J. 1968. "Locational Decision Factors in a Producers Model of Residential Development," Land Economics, Vol. 44, pp. 351-362.

The construction of new residences is examined by property value, and size of developer, in relation to the attraction elements of individual locations.

Kaiser, E. J. and S. F. Weiss. 1969. "Decision Agent Models of the Residential Development Process - A Review of Recent Research," Traffic Quarterly, Vol. 23, pp. 597-630.

Consumer and developer decision processes are reviewed, and the role of accessibility to each is discussed.

Kaiser, E. J. and S. F. Weiss. 1969. "Some Components of a Linked Model for the Residential Development Decision Process," Proceedings of the Association of American Geographers, Vol. 1, pp. 75-79.

Comments on the results of Butler, E. W. et. al. (1969): the role of accessibility would seem to be relatively unimportant in the residential location behaviour of individuals.

Kanaan, N. J. 1966. "Structure and Requirements of the Transport Network of Syria," Highway Research Record, Vol. 115, pp. 19-28.

The use of graph theoretic accessibility measurement and multiple regression techniques demonstrates the relationship between network structure and the spatial variation of population and economic characteristics of the 42 administrative divisions of Syria.

Kansky, K. J. 1963. Structure of Transportation Networks, Chicago: University of Chicago Department of Geography, Research Paper No. 84.

The analysis of various graph theoretic measurement procedures and their application to transportation networks.

Kantner, J. F. 1948. The Relationship Between Accessibility and Socio-Economic Status of Resident Lands, Flint, Michigan, Ann Arbor: University of Michigan, Institute for Human Adjustments.

Reveals that for this urban area at least the relationship between socio-economic status of residential land and accessibility to city center is not as simple as envisaged in the Burgess, E. W. (1926) model.

Kashuba, E. N. 1972. "Land-Use Models," pp. 27-61 in Catanese, A. J. (ed.) New Perspectives in Urban Transportation Research, Lexington, Massachusetts: D. C. Heath & Co.

Reviews land use models and comments on the role of accessibility in each.

Katz, L. 1953. "A New Status Index Derived from Sociometric Analysis," Psychometrika, Vol. 18, pp. 39-43.

Deviation and comment on application of the Shimbel-Katz accessibility index.

Kirby, H. R. 1969. Accessibility of a Point to Random Destination in a Uniform Circular Town, Cunthorne, Berkshire: G.B. Ministry of Transport, Road Research Laboratory Report LR 284.

A theoretical examination of accessibility and trip length.

Kissling, C. C. 1966. Transport Networks, Accessibility and Urban Functions: An Empirical and Theoretical Analysis, Montreal: unpublished Ph.D. Dissertation, Department of Geography, McGill University.

Urban economic structure is examined in relation to twelve accessibility variables in the New Brunswick-Nova Scotia urban system.

Kissling, C. C. 1968. "Accessibility and Urban Economic Activity Structure," pp. 143-152 in Proceedings of the Fifth New Zealand Geography Conference, Auckland, 1967, Auckland: New Zealand Geographical Society.

Highway accessibility, measured by nine proximity variables, is regressed upon urban economic activity dimensions, deemed by a factor analytic solution, revealed that only a few of the proximity variables were statistically significant as explanatory variables.

Kissling, C. C. 1969. "Linkage Importance in a Regional Highway Network," Canadian Geographer, Vol. 13, pp. 113-127.

Shimbel's graph theoretic accessibility index is adapted to take account of length of link and link importance, and is applied to the Nova Scotia highway network.

Kissling, C. C. and M. L. Gadd. 1971. "Before and After One Way Streets in Christchurch," pp. 143-149, in Proceedings of the Sixth New Zealand Geography Conference, Christchurch 1970, Christchurch: New Zealand Geographical Society.

Describes the improvements in accessibility following the introduction of a one way street system and provides a technique for measuring the extent of improvement.

Kivell, P. T. 1969. "Gradients of Urban Influence Among Middle Order Towns of the North West Midlands," Institute of British Geographers Study Group in Urban Geography, Process and Patterns of Urbanization, Keele Conference, September 1969.

An urban dominance study suggesting that urban influence decreases exponentially with distance away from the town/city center.

Knox, D. S. 1962. The Distribution of Land Values in Topeka, Kansas, Lawrence: University of Kansas, Bureau of Business and Economic Research.

Tests the hypothesis that land values vary: 1) inversely with distance from city center; 2) inversely with distance from major business throughfares; 3) directly with the distribution of population potentials in the city; 4) with the direction of growth of the city. Using multiple regression techniques almost 80 percent of the variation in urban land values is explained by these four dependent variables.

Kolars, J. and H. J. Malin. 1970. "Population and Accessibility: An Analysis of Turkish Railroads," Geographical Review, Vol. 60, pp. 229-246.

A simulation of the development of the Turkish railway network based on the assumption that rail lines were built reflecting access to the highest population totals.

Kuhn, H.A.J. 1968. "Factors Influencing Traffic Generation at Rural Highway Service Areas," Highway Research Record, Vol. 240, pp. 1-10.

Highway service areas are examined with respect to the factors influencing the amount of traffic that uses them, accessibility is described as an important variable.

Lachene, R. 1965. "Networks and the Location of Economic Activities," Regional Science Association, Papers and Proceedings, Vol. 14, pp. 183-196.

A theoretical examination of economic development within the territory served by a transportation network under conditions of network evolution.

Lakshmanan, T. R. 1964. "An Approach to the Analysis of Intra-urban Location Applied to the Baltimore Region," Economic Geography, Vol. 40, pp. 348-370.

A model for describing employment and indices of areal growth.

Lathrop, G. T., J. R. Hamburg and G. F. Young. 1965. "Opportunity-Accessibility Model for Allocating Regional Growth," Highway Research Record, Vol. 102, pp. 54-66.

Land use forecasting procedure based on an opportunity distribution model, where each activity has a given probability of location. The number of opportunities in a zone calculated as the product of vacant land and the development intensity assumed for that zone.

Lean, W. and B. Goodall. 1966. Aspects of Land Economics, London: Estates Gazette, Ltd.

General discussion of the role of accessibility for economic returns from individual locations.

Lee, T. R. 1963. "The Optimal Provision and Siting of Social Clubs," Durham Research Review, Vol. 4, pp. 53-61.

Benefits derived from siting either large social clubs in the city centers, or small social clubs in individual urban neighborhoods, are compared with the disadvantages of both.

Leigh, R. 1969. "Analysis of the Factors Affecting the Location of Industry Within Cities," Canadian Geographer, Vol. 13, pp. 28-33.

Survey material from Vancouver, British Columbia, reveals that industrialists do hold various accessibility factors as being important in industrial site selection.

Lijewski, T. 1964. "Influence of Transport Lines on Concentration of Population and Increased Commuting in the Warsaw Region," Geographia Polonica, Vol. 2, pp. 215-220.

Analyses the relationship between railway lines and population growth.

Lijewski, T. 1972. "Indices of Accessibility and Communication Service of a Territory," pp. 621-623 in Adams, W. P. and F. M. Helleiner (eds.) International Geography 1972 (Volume I), Toronto: University of Toronto Press.

Descriptive indices of accessibility and transportation provision.

Logan, M. I. 1966. "Location Behaviour of Manufacturing Firms in Urban Areas," Annals of the Association of American Geographers, Vol. 56, pp. 451-466.

Locational decisions in the siting of factories, with special reference to Sydney.

Lowry, I. S. 1964. A Model of Metropolis, Santa Monica, California: Rand Corporation, Memorandum RM-4035-RC.

Presents a model of urban land uses. For accessibility measurement discusses the effect of the urban spatial structure but also notes that the characteristics of an individual are also important.

Luce, R. D. and A. D. Perry. 1949. "A Method of Matrix Analysis of Group Structure," Psychometrika, Vol. 14, pp. 95-116.

Deviation of the Shimbel-Katz accessibility index.

Luce, R. D. 1950. "Connectivity and Generalized Degrees in Sociometric Group Structure," Psychometrika, Vol. 15, pp. 169-190.

Further discussion on the Shimbel-Katz index and associated properties of matrix representation of networks.

Lynch, K. 1961. "The Pattern of the Metropolis," Daedalus, Vol. 90, pp. 79-98.

Metropolitan form and plans for metropolitan expansion are critically examined. The most important elements of the metropolitan spatial pattern are described as its 'grain,' 'focal organization,' and 'accessibility.'

McGregor, D. R. 1953. "Daily Travel: Time and Distance Around Edinburgh," Scottish Geographical Magazine, Vol. 69, pp. 117-127.

The relative advantages of various settlements around Edinburgh for commuting by public transport facilities.

McIlwraith, T. F. 1966. Accessibility and Rural Land Utilization in the Yonge Street Area of Upper Canada, Toronto: unpublished Master's Thesis, Department of Geography, University of Toronto.

McIlwraith, T. F. 1970. "The Adequacy of Rural Roads in the Era Before Railways: An Illustration from Upper Canada," Canadian Geographer, Vol. 14, pp. 344-360.

Roads were found to be of limited importance in the choice of land by early settlers; occupancy tended to create the demand for roads, these roads then permitted further development which in turn demanded more roads.

McKenzie, K. D. 1966. "Structural Centrality in Communications Networks," Psychometika, Vol. 31, pp. 17-25.

A graph theory centrality measuring technique.

McLoughlin, J. B. 1969. Urban and Regional Planning: A Systems Approach, London: Faber and Faber.

Brief comment on potential type accessibility indices.

Madden, C. H. 1956. "Some Spatial Aspects of Urban Growth in the United States," Economic Development and Cultural Change, Vol. 4, pp. 371-387.

A study of the distance to nearest metropolitan area - population change relationship.

Marble, D. F. 1959. "Transport Inputs at Urban Residential Sites," Regional Science Association, Papers and Proceedings, Vol. 5, pp. 253-266.

An empirical examination of the transport inputs of a sample of households in Cedar Rapids, Iowa (1949). Argues that three main factors influence transport inputs at residential sites: socio-economic structure of the household; availability of transport and accessibility of households residential site to other elements of the transport system.

Marble, D. F. 1962. "Some Cultural and Social Aspects of Transport Impact in Underdeveloped Areas," pp. 39-43 in Pitts, F. R. (ed.) Urban Systems and Economic Development: Papers and Proceedings of a Conference on Urban Systems Research in Underdeveloped and Advanced Economics, Eugene: University of Oregon, School of Business Administration.

Draws attention to some of the economic aspects of improvements in accessibility in an economically 'backward' region, while research has mainly concentrated on these economic aspects, Marble stresses, and exemplifies, the need for research into the cultural and social aspects of transport impact in order to generate incisive statements about the process of regional development and its relation to transportation change in underdeveloped areas.

Marble, D. F. 1965. "Residential Location and Household Travel Behaviour," Highway Research Circular, Vol. 12, pp. 11-16.

An analysis of the role of accessibility in the residential location process and travel behaviour, contends that in order to understand the role of individual factors one must analyse the 'proper behavioural unit' - in this case the household.

Marble, D. F. 1967. "A Theoretical Exploration of Individual Travel Behaviour," pp. 33-53 in W. L. Garrison and D. F. Marble (ed.) Quantitative Geography: Economic and Cultural Topics, Evanston, Illinois: Northwestern University, Studies in Geography, No. 13.

An examination of individual movement patterns as a function of: 1) the spatial preference of the individual; 2) the individual's location within the overall space economy; 3) the relative ease of movement within the system. Game theory formulations are presented for analyzing the complex decision situations of individual travel behaviour.

Marble, D. F. and S. R. Bowlby. 1968. "Shopping Alternatives and Recurrent Travel Patterns," pp. 42-75 in Horton, F. E. (ed.) Geographical Studies of Urban Transportation and Network Analysis, Evanston, Illinois: Northwestern University Studies in Geography, No. 16.

Individual shopping patterns and the role of accessibility in shopping travel patterns.

Martin, W. T. 1953. The Rural-Urban Fringe: A Study of Adjustment to Residence Location, Eugene: University of Oregon Press.

Attitudes to urban fringe residential location and accessibility are examined in the Eugene-Springfield area.

Martin, W. R. 1957. "Ecological Changes in Satellite Rural Areas," American Sociological Review, Vol. 22, pp. 173-183.

Mayer, H. M. 1969. The Spatial Expression of Urban Growth, Washington, D.C.: Association of American Geographers, Communion on College Geography Resource Paper No. 7.

A brief review of the role of accessibility in the land development process.

Mennear, A. D. 1958. Accessibility is a Rural Area: The Changing Relationship Between Hexham and its Hinterland Settlements from 1911-1957, with Special Reference to the Growth of Motor Transport, Newcastle-upon-Tyne: University of Newcastle-upon-Tyne, Department of Town and Country Planning, unpublished B.A. Thesis.

Examines a period in which accessibility of the rural population, of this area of Northcumberland, was being reduced with the withdrawal of public transportation services, yet for other individuals the advent of motor transport had increased their access to facilities.

Mitchell, N. 1972. The Indian Hill Station: Kodai Kanal, Chicago: University of Chicago, Department of Geography, Research Paper No. 141.

The importance of accessibility to the development of Indian Hill Stations.

Mitchell, R. B. and C. Rapkin. 1954. Urban Traffic: A Function of Land Use, New York: Columbia University Press.

Mohring, H. 1961. "Land Values and the Measurement of Highway Benefits," Journal of Political Economy, Vol. 69, pp. 236-249.

A classical land value - accessibility to city center approach.

Moline, N. T. 1971. Mobility and the Small Town 1900-1930: Transportation Change in Oregon, Illinois, Chicago: University of Chicago, Department of Geography Research Paper No. 132.

Demonstrates how improvements in mobility increased individual's accessibility to opportunities and enabled a new territorial scale of activity to be established.

Moore, E. G. 1972. Residential Mobility in the City, Washington, D.C.: Association of American Geographers Commission on College Geography Resource Paper No. 13.

Reviews some studies that have related accessibility to residential location and mobility.

Muraco, W. A. 1971. Transport Accessibility as a Contemporary Factor in Industrial Location: A Comparative Analysis of the Indianapolis and Columbus Standard Metropolitan Statistical Areas, Columbus: unpublished Ph.D. Dissertation, Department of Geography, Ohio State University.

The applicability of accessibility to intra-metropolitan industrial location is discussed. An accessibility index is derived by a principal components solution applied to various graph theory based measures, his index clearly demonstrates the need to analyse accessibility as more than a purely distance minimization measure.

Muraco, W. A. 1972. "Intraurban Accessibility," Economic Geography, Vol. 48, pp. 388-405.

A description of the graph theory based accessibility model used in the author's doctorate.

Muth, R. F. 1961. "The Spatial Structure of the Housing Market," Regional Science Association, Papers and Proceedings, Vol. 7, pp. 207-220.

Studies the relationship between residential population densities gradients and distance from city center in 46 United States cities in 1950.

Muth, R. F. 1961. "Economic Change and Rural-Urban Land Conversions," Econometrica, Vol. 29, pp. 1-23.

Von Thunen type model of urban fringe land use determination under equilibrium conditions.

Nyshuen, J. D. and M. F. Dacey. 1961. "A Graph Theoretical Interpretation of Nodal Regions," Regional Science Association, Papers and Proceedings, Vol. 7, pp. 29-42.

A graph theory method is applied to telephone flow data, to determine the degree of association between cities.

Nysten, J. D. 1967. "A Theory and Simulation of Intraurban Travel," pp. 54-83 in Garrison, W. L. and D. F. Marble (eds.) Quantitative Geography: Economics and Cultural Topics, Evanston, Illinois: Northwestern University Studies in Geography No. 13.

Urban travel patterns and access to urban facilities.

Olagbaiye, J. A. 1968. "Towards Manufacturing Locational Analysis in Southern Nigeria: A Population Potential Model," Nigerian Geographical Journal, Vol. 11, pp. 11-20.

The relative advantages and disadvantages of population potential and market potential models as measures of accessibility are discussed with reference to industrial location in Southern Nigeria.

O'Sullivan, P. M. 1968. "Accessibility and the Spatial Structure of the Irish Economy," Regional Studies, Vol. 2, pp. 195-206.

Economic, social and demographic characteristics of Irish counties are regressed with a 'distance-weighted' Shimbel accessibility index.

O'Sullivan, P. M. 1969. Transport Networks and the Irish Economy, London: London School of Economics Geographical Papers No. 4.

Contends that activities will concentrate in locations where their 'functional costs' are minimized, and that the process of growth trends towards a geographical pattern that minimizes the total cost of distance to the economy. Using the arterial road network relates accessibility to various characteristics of Irish counties.

Owen, W. 1972. The Accessible City, Washington, D.C.: Brookings Institute.

"New urban designs are revealing that the task of increasing urban mobility may not call for more transportation at all, but may depend more on such non-transportation solutions as the locations, densities and aesthetics of everything being done to accommodate urban man."

Pahl, R. E. 1964. Urbs in Rure: The Metropolitan Fringe in Hertfordshire, London: London School of Economics, Geographical Papers No. 2.

Characteristics of commuter villages in Hertfordshire are described and examined. Comments on the role of accessibility in community change, and on the relevance of Bogue's (1949) ecological urban dominance theory.

Pahl, R. E. and E. Craven. 1970. "Residential Expansion: The Role of the Private Developer in the South East," pp. 146-164 in Pahl, R. E. (ed.) Whose City?, London: Longman.

Compares the 'functionalist' and 'behaviouralist' approaches to residential location in the city.

Pendakur, V. S. and G. R. Brown. 1969. "Accessibility and Environmental Quality," Highway Research Record, Vol. 277, pp. 40.

A summary of a research project testing consumer opinions on pedestrian movement and motor vehicle accessibility.

Pendleton, W. C. 1963. The Value of Highway Accessibility, Chicago: unpublished Ph.D. Dissertation, Department of Economics, University of Chicago.

Attempts to find the value that residents in Washington, D.C. place on highway accessibility to job opportunities and the CBD, by utilizing multiple regression analysis and cross sectional data of residential land sales prices.

Pendleton, W. C. 1963. "Relation of Highway Accessibility to Urban Real Estate Values," Highway Research Record, Vol. 16, pp. 14-23.

Empirical relations developed between: 1) job accessibility and distance to CBD; 2) driving time to CBD and distance to CBD; 3) proportion of job trips to CBD and driving time to CBD; 4) house prices and job accessibility, driving time and distance to CBD; Data from the 1955 Washington Metropolitan Area Transportation Study.

Perry, P. J. 1969. "Working Class Isolation and Mobility in Rural Dorset, 1837-1936: A Study of Marriage Distances," Transactions of the Institute of British Geographers, Vol. 46, pp. 121-141.

A description of the increase in marriage distances with the break down in isolation.

Peterson, G. L., R. D. Worrall and M. J. Redding. 1969. "Toward A Theory of Accessibility Acceptance," pp. 198-210 in Sanoff, H. and S. Cohn (eds.) Proceedings of the First Annual E.D.R.A. Conference June 1969.

Peterson, G. L. and R. D. Worrall. 1970. "An Analysis of Individual Preference for Accessibility to Selected Neighborhood Services," Highway Research Record, Vol. 305, pp. 99-111.

An examination of preferred location of facilities relative to the individual. Found that residents could not place a monetary value on what they considered: non-optimal situations, situations being judged as being either acceptable or unacceptable.

Pietkiewicz, S. 1968. "Differential Isochrones: A Map of the Progress of Temporal Accessibility," Geographia Polonica, Vol. 13, pp. 5-8.

Minimum travel times from Warsaw to its hinterland, 1952-1962.

Pitts, F. R. 1965. "A Graph Theoretical Approach to Historical Geography," Professional Geographer, Vol. 17, Part 5, pp. 15-20.

Graph theory accessibility indices used to examine the position of Moscow, in the light of the commonly held view that Moscow was strategically placed on trade routes.

Pocock, D.C.D. 1968. "Shopping Patterns in Dundee: Some Observations," Scottish Geographical Magazine, Vol. 84, pp. 108-116.

Demonstrates how accessibility can influence retail hinterlands.

Pred, A. 1964. "The Intra-Metropolitan Location of American Manufacturing," Annals of the Association of American Geographers, Vol. 54, pp. 165-180.

Historical analysis of 10 metropolitan areas demonstrates the role that accessibility has played in manufacturing location decisions.

Prihar, Z. 1956. "Topological Properties of Telecommunications Networks," Proceedings of the Institute of Radio Engineers, Vol. 44, pp. 927-933.

Introduction to the Shimbel-Katz accessibility index.

Quinn, J. A. 1940. "The Burgess Zonal Hypothesis and its Cities," American Sociological Review, Vol. 5, pp. 210-218.

A critical assessment of the arguments of some critics of Burgess (1926).

Ray, D. M. 1965. Market Potential and Economic Shadow, Chicago: University of Chicago, Department of Geography Research Paper No. 101.

The location of subsidary works in Ontario of United States companies in terms of market potential and increasing opportunities between plant and headquarters locations.

Redding, M. J. 1969. "The Quality of Residential Environments: Preference for Accessibility for Residential Opportunities," in Selle, H. D., Dajani, J. S. and G. L. Peterson (eds.) Quality of the Environment: Quantitative Analysis of Human Response, Evanston, Illinois: Northwestern University, Department of Civil Engineering.

Redding, M. J. 1970. The Quality of Residential Environments: Preference for Accessibility to Residential Opportunities, Evanston, Illinois: unpublished Ph.D. Dissertation, Department of Civil Engineering, Northwestern University.

Suggests that the relationship between accessibility and residential location is somewhat more subtle than is implied in earlier studies. Poshlats that the relation between accessibility and locational valuation is more linear, high proximity to work and amenities, as well as low accessibility, producing a stressful situation for households.

Redding, M. J. and G. L. Peterson. 1972. "Adequacy of the Spatial Organization of Residential Neighborhoods: The Residents Point of View," Highway Research Record, Vol. 410, pp. 64-5.

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Wilbanks, T. J. 1972. "Accessibility and Technological Change in Northern India," Annals of the Association of American Geographers, Vol. 62, pp. 427-436.

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